Pollination and The Honey Bee

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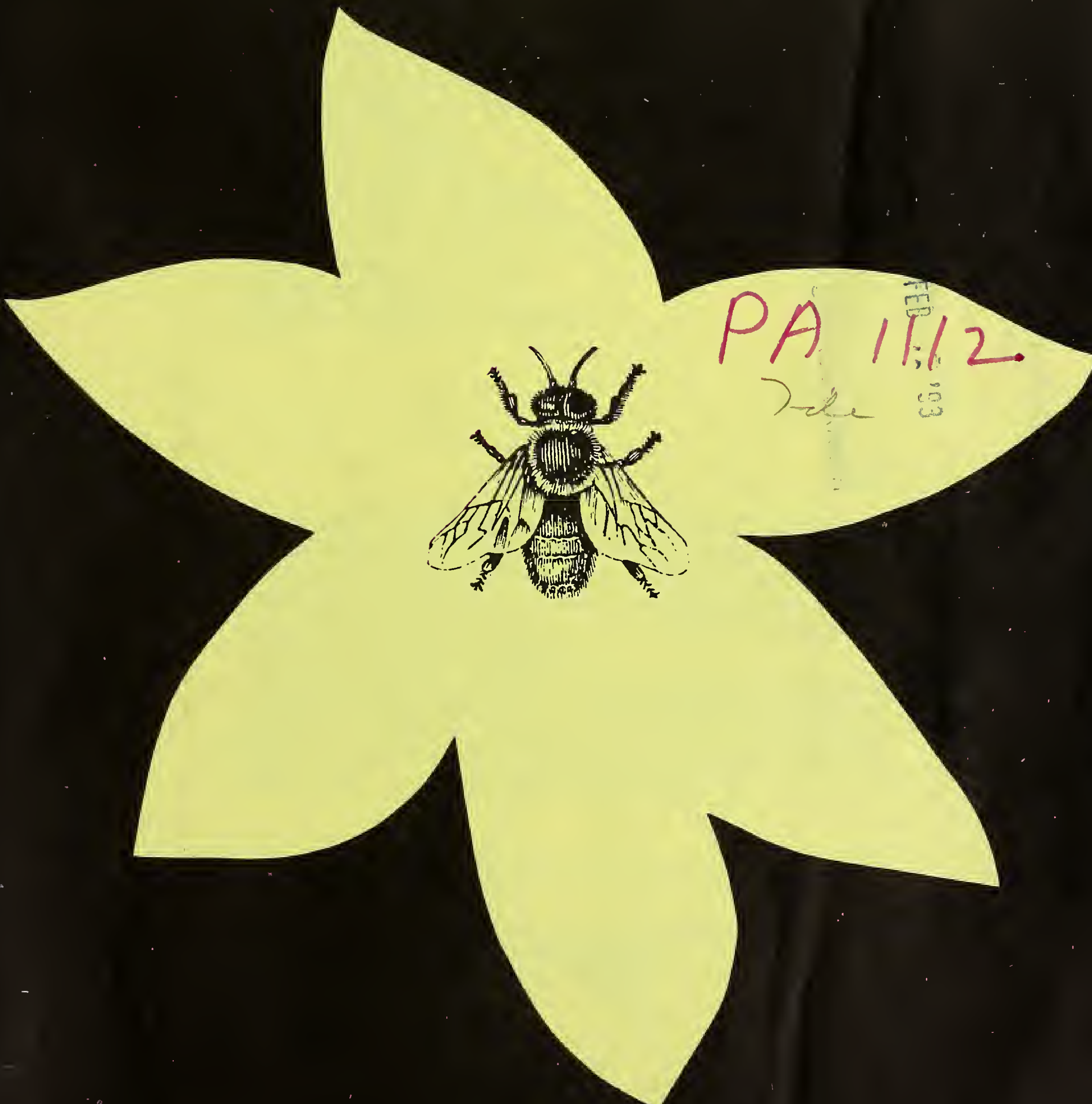

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FOREWORD

This guide was prepared in response to a growing concern in both the public and private sectors about the problems that beset beekeepers and crop producers, and to assist in better understanding of the interests and operations of each. Several example programs are included to give ideas on methods of approaching problems and arriving at solutions.

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COMMITTEE: Extension Service. USDA

Fred E. Westbrook, Agronomist, Chairman
Paul W. Bergman, Entomologist
Robert A. Wearne, Horticulturist

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SUMMARY

Pollination is essential for the commercial production of many fruit, vegetable, and seed crops. Some plants are self-pollinated, some are pollinated by wind, but many must rely upon nectar- and pollen-collecting insects to transfer the pollen. In some crops the pollen must be transferred from the male parts of the flower to the female parts of the same flower. In others, the transfer must be between flowers on the same plant, and in still other crops, the pollen must be transferred from flowers of one variety to those of another.

If pollinating insects are present in sufficient numbers they can adequately pollinate a crop. If there are not enough local pollinating insects, the grower may want to introduce pollinators from other areas to assure adequate pollination and consistent high production.

The honey bee is the most widely used and most easily managed insect for pollination purposes. This is because of the nature of honey bees and the extensive amount of data that has been gathered about them. Perhaps 80 percent of the insect pollination of crops in the United States is done by honey bees. However, wild bees such as bumble bees, leafcutter bees, and alkali bees are also important, particularly in the pollination of certain crops in restricted locations.

The protection of these and other beneficial insects from insecticides, while controlling harmful insects, may create problems for both the grower and the beekeeper. There is no easy solution, although the problem can be reduced by mutual understanding, cooperation, and an honest effort by both parties.

Written agreements between the beekeepers and producers whose crops need pollination will promote a better understanding between the two parties.

The Extension Service, with lines of communication reaching into every county, can help solve some of the problems that beset beekeepers and crop producers. Educational programs and material can be developed and provided by Extension specialists. Interdisciplinary workshops can be planned involving all concerned parties and community leaders. This service can help to promote a better knowledge of the dependence of the farmer and the beekeeper upon each other, to the betterment of individuals, the community, and the country as a whole.

The purposes of this publication are:

1. To point out the importance of the honey bee as the number one insect pollinator.
2. To outline an educational program that will enhance the understanding and show mutual interdependence between beekeepers and crop producers.
3. To motivate the beekeeper and the crop producer to solve problems of mutual concern.
4. To encourage multistate and regional program planning.
5. To list research in progress and publications available pertaining to crop pollination by insects.

Honey bees (*Apis mellifera* L.) are of great value to agriculture. They are the only known pollinator of many crops that can readily be moved into an area in mass numbers when desired. Honey bees visit a wide variety of plants. Their biology and behavior are well known as a result of extensive studies by amateur and professional apiculturists. In addition, honey bees consistently visit flowers from early spring to late fall. Because of these traits, research should be intensified to determine the most efficient use of the honey bee as a pollinator. This should be accompanied by parallel research on other insects commonly associated with crop pollination.

Management of wild bees for pollination is an important industry in some areas. Research on pollinating insects other than the honey bee has been limited primarily to three genera of bees: bumble bees (*Bombus spp.*), the alkali bee (*Nomia melanderi*), and the leafcutter bee (*Megachile rotundata*). Other insects with the exception of the tiny fig wasp are of limited value in the large-scale pollination of commercial agricultural crops.

While many beekeepers rent their colonies to farmers for pollination of fruit, vegetable, oilseed, and legume seed crops, rental of bees for pollination has been relegated to a secondary position in the minds of most beekeepers. Because of its importance to the national food supply, honey bee pollination of crops should merit major concern by growers, beekeepers, and the general public.

The commercial beekeeper most often considers honey production as his primary source of income. Until recently many operators found honey production an unprofitable enterprise and were finding it difficult to stay in the business. During the last 20 years the number of honey bee colonies in the United States has declined at an average rate of 1 percent per year. The following reasons are suggested for this trend, but supporting data are meager:

1. Bee pasturage is decreasing because of modern farming practices and urbanization.
2. Pesticide poisoning has increased.
3. Bee diseases have reduced numbers.
4. The relatively low price received for honey has decreased incentives to replace beekeepers.

There has been poor communication between the grower and the beekeeper on the value of bees for pollination and on the expense involved in maintaining and supplying strong colonies. Much of the research on honey bees has been directed toward honey production. This was based on the assumption that a colony which stores a satisfactory crop of honey will also be a satisfactory colony for pollination purposes. Data to substantiate this assumption are lacking.

Because of the importance of bees for pollination, additional research is needed to define the pollination needs of agricultural crops and determine the best means of pollination with honey bees or other pollinators.

POLLINATION AND REPRODUCTION IN PLANTS

Pollination is the transfer of pollen from the anthers to the stigma of flowers. The flowers of most crops must be pollinated to produce seeds. Many fruits and vegetables need pollination to produce edible portions.

Pollination alone does not insure fruit or seed set. The pollen must be capable of germinating, and it must be from the right plant or variety. It must also reach the female part of the flower, the stigma, at the proper time. Then, it sprouts a tube that grows down into the ovary of the flower and fertilizes the ovules that develop into seeds.

Some plants, like certain varieties of peaches, will develop seeds and fruit if pollen is transferred from the anthers to the stigma of the same flower. Such plants are referred to as self-fertile. This may not necessarily mean that the flowers are capable of self-pollination. Some outside agency may be required or helpful in moving the pollen from the anthers to the stigma.

In other plants, for example, apples, the pollen must come from another plant, even a different variety. Such plants are referred to as self-sterile. When pollen from different varieties is required, the grower is forced to interplant pollenizer trees throughout the orchard to provide compatible pollen.

Crops that will not set a profitable crop without the benefit of cross-pollination are said to be dependent upon cross-pollination. Those that will set some seeds without the benefit of a cross-pollinating agent, but will set more or better fruit if pollinated, are said to be benefited by cross-pollination. Table 1 lists the cultivated crops that are either benefited by or dependent upon insect pollination.

INSECTS OF MAJOR IMPORTANCE IN PLANT POLLINATION

As previously mentioned, insects that are recognized as being of major importance in plant pollination are: (1) the bumble bee, (2) the alfalfa leafcutter bee, (3) the alkali bee, and (4) the honey bee.

The Bumble Bee

The bumble bee is regarded as one of the most efficient pollinators of many crops but is especially valuable in pollinating those flowers in which its large size facilitates pollen transfer, such as cotton, certain legumes, and certain tree fruit. Its long tongue makes it especially efficient in pollinating flowers with deep narrow corolla tubes from which only insects with long tongues can obtain nectar.

Although bumble bees are efficient pollinators, they are usually too scarce to pollinate large areas of agricultural crops. Furthermore, their numbers fluctuate unpredictably from place to place and from year to year so that even where they are relatively abundant one year they may be scarce the next. The population seems to have declined over recent years because more intensive cultivation of the land has destroyed nest and hibernation sites. Herbicides destroy wild flowers on which bumble bees rely for food, and insecticides may destroy the bees themselves.

Various suggestions have been made as to how the bumble bee population may be increased. Farmers might grow small plots of nectar-producing flowers to help provide for the colonies during times of scarcity, or small areas of uncultivated land might be left in which bumble bees can nest and hibernate. Steps could also be taken to protect such areas from exposure to herbicides.

TABLE 1.

Crops That Are Dependent Upon or Benefited by Insect Pollination.

- Alfalfa
- Almonds
- Apples
- Asparagus
- Avocado
- Blackberry
- Blueberry
- Broadbeans *
- Broccoli
- Brussels sprouts
- Buckwheat
- Cabbage
- Caraway
- Carrots
- Cauliflower
- Celery
- Cherry
- Chestnut
- Chicory
- Clover
  - Alsike
  - Arrowleaf
  - Ball
  - Berseem
  - Crimson
  - Persian
  - Red
  - Rose
  - Strawberry
  - White
  - White Ladino
- Coconut
- Coffee *
- Collards
- Coriander
- Cotton *
- Crabapple
- Cranberries
- Crownvetch
- Cucumbers
- Currants
- Dewberry
- Dill
- Drug plants
- Eggplant
- Endive
- Feijoa
- Fennel
- Figs
- Flax *
- Garlic
- Gooseberries
- Grapes (muscadine)
- Guar
- Guava
- Jujube
- Kale
- Kidneyvetch
- Kiwi, Chinese gooseberry
- Kohlrabi
- Kudzu
- Leek
- Lespedeza
- Lima beans *
- Litchi or Lychee
- Loquats
- Macadamia nut
- Mango
- Muskmelons
  - Casaba
  - Cantaloup
  - Crenshaw
  - Honeyball
  - Honey Dew
  - Honeyrock
  - Pershaw
  - Persian
  - Santa Claus
- Mustard
- Nectarines
- Okra *
- Onions
- Orange *
- Papaya
- Parsley
- Parsnips
- Passion fruit
- Peaches
- Pears
- Peppers
- Persimmon (native)
- Plum and Prune
- Pumpkin
- Radish
- Rape
- Raspberry
- Rutabaga
- Safflower *
- Sainfoin
- Squash
- Strawberry
- Sunflower
- Sweetclovers
- Tangelo
- Tangerine
- Tendergreens
- Trefoil
- Tung
- Turnips
- Vetch
- Watermelons

* Pollination beneficial

The Alfalfa Leafcutter Bee

The alfalfa leafcutter bee was inadvertently introduced from Eastern Europe or Western Asia to the East Coast of North America in about 1930 and spread westward, reaching Utah in 1954 and Oregon in 1958.

This bee occupies a variety of nesting sites including beetle burrows; nail holes; holes bored in logs or boards; hollow stems; drinking straws; metal, plastic and rubber tubes. Research on its life history revealed techniques that made its commercial exploitation possible.

Alfalfa leafcutter bees are valuable pollinators of certain crops and their usefulness has increased as management techniques improved. Studies are in progress to increase the efficiency and commercial use of the alfalfa leafcutter and other wild bees as pollinators of alfalfa grown for seed and for certain vegetables grown in greenhouses. These studies are being done at the USDA Wild Bee Pollination Research Laboratory located at Logan, Utah; at Oregon State University; University of Idaho; Washington State University; and at the Canada Research Station, Lethbridge, Alberta. The alfalfa leafcutter bees can now be purchased in their pupa stage and allowed to emerge at the appropriate time to pollinate commercial crops.

The Alkali Bee

The alkali bee is native to certain arid and semi-arid portions of the West where most of the precipitation occurs in the winter. In nature, the alkali bee is confined to localities where the soil is sub-irrigated over a hardpan layer which leads to moist relatively bare alkali spots suitable for nest sites. By irrigating new areas and by planting an attractive host plant, such as alfalfa, man has encouraged this species.

Alkali bees increase yields of alfala seed because they forage the blooms among the lower foliage. They also forage in somewhat cooler, windier weather than the leafcutters. Yields of more than 2,000 pounds of clean seed per acre have been consistently obtained with the alkali bee on some fields of alfalfa. However, there are problems in maintaining a high population of these bees.

Conditions that the grower must maintain to produce large numbers of alkali bees are: (1) proper soil moisture throughout the area, (2) firm compact soil without either a crust or a fluffy layer at the surface, (3) essentially bare soil or soil with sparse surface vegetation (both a slight slope and limited vegetation will help protect the bees from summer rains), and (4) a fine, sandy loam soil with less than 10 percent clay. The specificity of the alkali bee restricts its usefulness in the United States to a limited area in the arid and semi-arid Northwest. New nesting sites can be established if the soil is properly prepared and cores or blocks of pupae-laden soil are transplanted from inhabited sites.

The Honey Bee

The honey bee is a dual-purpose insect in that it is capable of producing honey and other byproducts for the beekeeper, and at the same time it can pollinate crops and other plants for the grower. Since honey bees are the most widely dependable pollinators, primary consideration is given here to the pollinating activities of the honey bee. Like other bees, they visit flowers methodically to collect nectar and pollen and do not destroy the plant by feeding on it in the pollination process.

Although various species of bees contribute to crop pollination, an estimated 80 percent of pollination is done by the honey bee.

The unusually industrious honey bee visits a wide variety of plant types, more than any other insect. In a single day, one bee may make a dozen or more trips from the hive and it may visit several thousand flowers. But, on each trip it usually confines its visits to one plant species, collecting one kind of nectar and distributing one kind of pollen. At the same time thousands of bees from the same hive are doing the same. This characteristic, along with its large and hairy body, enables the honey bee to accumulate and distribute an abundance of pollen, and makes it one of our most valuable pollinating

agents. Colonies of honey bees can be moved easily and quickly to any location to concentrate bee pollination activities in areas where needed.

Strong colonies are important. There is no standard number of honey bees in a colony; therefore, the grower should have reliable information about differences in colony strength before renting bees for pollination. Colony strength can be described as the number of bees in the hive or the volume of a hive that is constantly occupied by bees. A strong colony has most of the frames covered with bees in each section. (About 15,000 bees are usually contained in each deep section.) When such a hive is open on a mild day, bees will immediately appear to "boil over" and cover the tops of the frames. Weak hives at any price are a poor investment. Such hives do not pollinate efficiently, particularly during marginal temperatures for bee flight. Crop yields may suffer if the crop flowers profusely and there are insufficient bees on the flowers.

Because of the wide variety of conditions that can exist in any area, the precise number of colonies needed for adequate pollination cannot be given. However, the number of honey bee colonies required depends on the number of natural pollinators already in the area, the relative attractiveness of the crop to bees, and the number and acreage of other crops that may be competing for the attention of the pollinating insects.

Colony distribution in the field is important. Honey bees usually pollinate flowers more thoroughly within 100 yards of their colonies than they do flowers at greater distances. To get the best coverage, therefore, the colonies should be placed in small groups throughout the fields or orchards to be pollinated. In fields of more than 40 acres, put the group of colonies one-tenth of a mile apart in all directions. In fields of less than 40 acres, place the groups of colonies along the borders at the same spacing. For more detailed information on placement of honey bees to pollinate crops, see USDA Leaflet No. 549 entitled *Using Honey Bees to Pollinate Crops.*

THE ECONOMICS OF POLLINATION

Despite the value of pollination by honey bees to agricultural production, no nationwide study has been made of production costs and returns associated with pollination by honey bees. Some studies have been made in specific areas of the United States on the economics and practices of typical beekeepers involved in honey production. In general, operating costs of honey producers and those in pollination services are related. Pollination fees are more dependable than honey crops for most beekeepers, although they amount to only about 20 percent of the total income.

Some beekeepers who rely on honey production supplement their income from crop pollination. Consequently, the beekeeping industry is unique in providing pollination services for which payment may or may not be received while primarily producing another salable product. Cost factors the beekeeper must consider are: purchase of bees, costs of hives, drugs, tools, bee pastures, sites, rent, wearing apparel, buildings, depreciation, honey house, equipment, storage, insurance, interest on investment, land investment, maintenance, market assessments, paid labor, power equipment, shop equipment, taxes, transportation, and utilities. Among these, labor is perhaps the greatest factor.

Extra hidden costs in managing bees for pollination as opposed to honey production include having more queens damaged or lost, more frequent inspection of colonies, extra wear and tear on equipment in moving, extra highway transportation vehicles, hive loaders or fork lifts, greater chance of losing colonies from insecticide damage, a greater chance to pick up disease, and the possible loss of a honey

crop while the bees are pollinating the grower's crop. Size of the operation has a direct bearing on cost and return, as do regional differences across the United States in such things as availability and concentration of nectar- and pollen-producing crops, building requirements, climate, farming practices, land use and land values.

BEEKEEPING REGIONS IN THE UNITED STATES

The many environmental factors that affect plant pollination and insect activity make it important to adapt plant pollination programs to local situations. It is important to evaluate local variables and incorporate them into the pollination planning effort. The continental United States has seven geographical beekeeping regions (based on climate, flora, and land topography) which affect beekeeping operations and management, as shown in the map, figure 1.

Program planning for pollination should be considered from the regional and multistate levels as well as the local level. Pollination activities may vary within a region and in some cases may overlap between regions. Programs often would be better implemented if they were developed without stressing the importance of State boundary lines, although different laws or regulations may have to be considered. A regional or multistate pollination program has several advantages:

1. It encourages public and private agencies and producer groups to jointly plan and produce educational materials and programs.
2. It supports needed research.
3. It creates a better understanding of regulatory procedures.
4. It permits cost sharing.
5. It increases the likelihood that all growers will receive pollination services even if some disaster strikes one of the beekeepers.

Those concerned are usually aware of local management practices, problems, and environmental factors in their own areas. Few, if any, individuals or groups have all the answers or know all the problems when relating program planning to broader areas. Thus, planning a regional crop pollination program should involve workers in Extension, regulatory agencies, research, beekeeping, crop production, pesticide application, and other public or private agencies.

RECOGNIZED PROBLEMS

The present challenge is to manage or control harmful and destructive insects without killing beneficial insects (including honey bees and other pollinating insects). Insecticides, when properly used, can benefit beekeepers as well as farmers. This can be done by providing more damage-free plants which produce more food for bees, livestock, and humans. Part of the problem is knowing how and when to use the proper insecticide. The other part of the problem is the human behavior factor and relationships among the concerned parties.

Bee losses from insecticides may not be entirely avoided, but they can be reduced by cooperative efforts between beekeepers and crop producers. This requires a mutual understanding and exchange of information.

The newly amended Federal Insecticide, Fun-

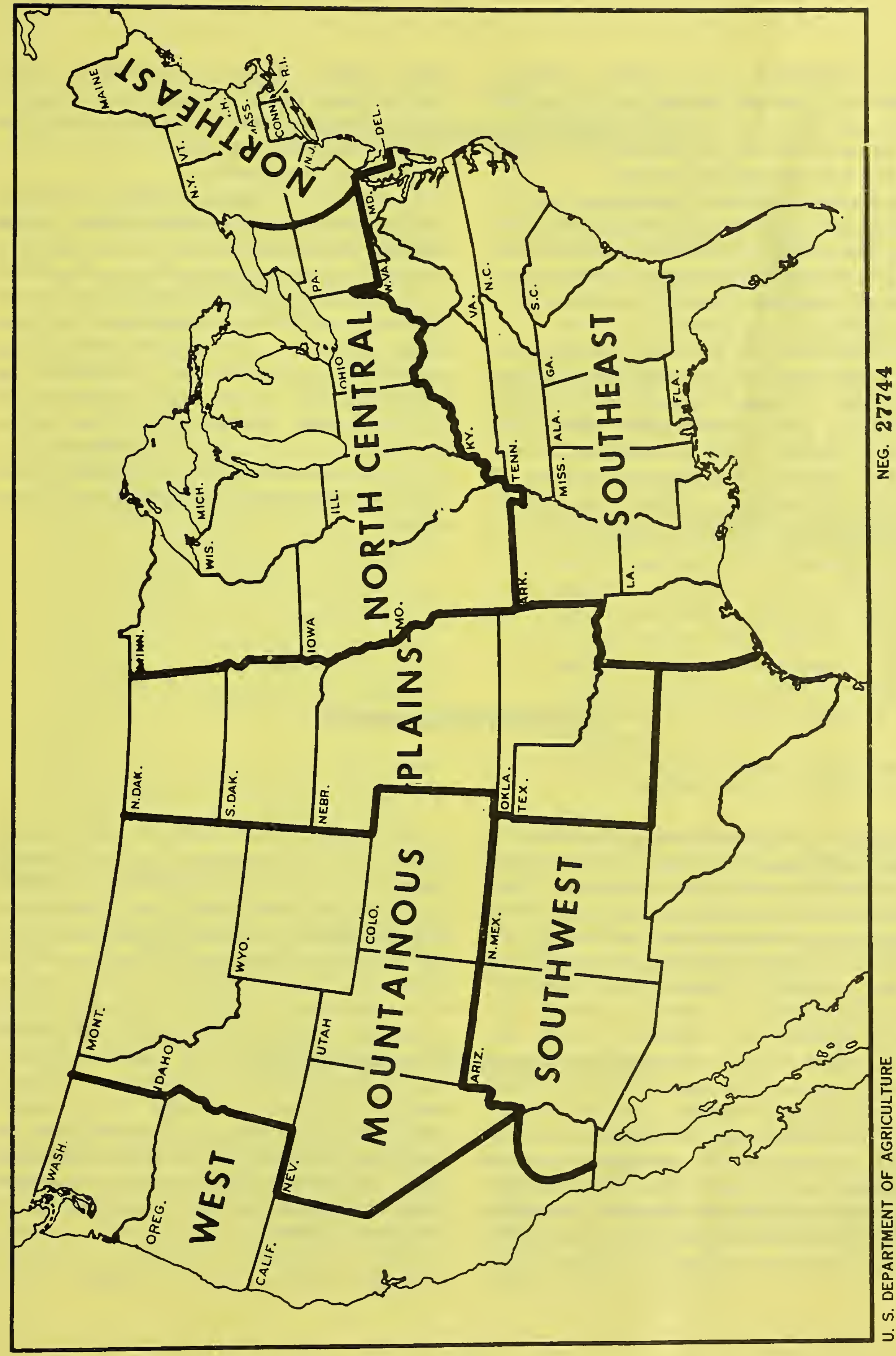

Figure 1—Beekeeping areas of the United States.

gicide, Rodenticide Act requires pesticide applicators to receive training and be certified to use restricted-use materials. This training includes use of insecticides in relation to honey bees and other pollinating insects.

The pesticide applicator, the farmer, and the beekeeper should all have a working knowledge of such insecticide use factors as proper dosage, methods of application, type of formulation, timing of application, toxicity to different insects, and drift of materials.

It is important to follow all recommended procedures in notifying interested parties when any change is initiated in operating practices, when such a change affects either party. Each individual should provide the other parties with his name, address, and telephone number. In addition, the beekeeper should post this information in the apiary on placards that are easily readable. This same information should also be made available, along with a map, to county Extension offices, pesticide dealers, and in some instances, the office of the State Commissioner of Agriculture.

In addition to farmer-beekeeper concerns over use of insecticides and bee losses, a good working relationship should be established on implementing an adequate pollination service to get maximum crop yields. This requires a working knowledge of both operations. The beekeeper depends on the farmer for bee forage and the farmer depends on the beekeeper for pollination. Their cooperation and understanding are essential. The beekeeper in the pollination business who provides a dependable service to the grower may do so at considerable expense and should be properly recognized and reimbursed.

THE WRITTEN CONTRACT

Honey bee colonies can usually be rented for pollinating crops either from a custom pollination service or from a local beekeeper. When this is done there should be a written contract or agreement between the grower and the beekeeper. This agreement should cover: (1) number and strength of colonies to be used; (2) plan of distribution of colonies in the field; (3) time of delivery and removal; (4) the beekeeper's right of entry to service his colonies; (5) the degree of protection from pesticides that will be given the bees; (6) plan of payment of the rental fee; (7) penalties for poor quality or service by the beekeeper or breach of promise by the grower; and (8) rewards or bonuses for exceeding the minimum in quality, service, protection, or time of financial settlement.

The contract should spell out the responsibilities of both the beekeeper and the farmer to minimize future misunderstanding and emphasize the expectations, rights, and obligations of both the farmer and the beekeeper. Standards should be set to include such things as: number of bees and type of equipment needed, the density and placement of hives in the field, methods of keeping records, and financial commitments. The grower should learn at least enough about bees to determine if he is receiving the colony quality and service he desires. The beekeeper should also learn as much as possible about the crop to be pollinated, layout of the land, access roads, soil, terrain, and location of competitive crops. (Examples of items to include in the agreement follow.)

SAMPLE POLLINATION AGREEMENT

A written contract signed by the beekeeper and the grower usually insures better pollination service. The contract should include the following:

1. Date and season of pollination.
2. Beekeeper's name, address, and telephone number.
3. Grower's name, address, and telephone number.
4. (a) Name of the crop, (b) location of the crop.
5. Number of colonies ordered.
6. Description of distribution patterns of colonies in the field.
7. Quality and quantity of pollinating unit to be delivered (strength of colonies).
8. (a) Rental fee per pollinating unit. (b) Total rental fee to be paid, time, place, and method of payment with penalties for nonpayment at specified time, and recourse for collection by the beekeeper or his attorney in the event of nonpayment.
9. The beekeeper should be compensated by the grower for all extra movements of the colonies in or out of the field.

The grower should agree to:

1. Give specified number of days' notice to the beekeeper prior to bringing colonies to and removing them from the crop.
2. Give specified number of days' notice to the beekeeper prior to requesting removal of colonies from the crop.
3. Use no toxic insecticide on the crop during the rental, except with the understanding and consent of the beekeeper.
4. Inform beekeeper if any known toxic insecticides are to be applied in the flight range of the bees.
5. Assume liability for stock damage and vandalism.

The beekeeper should agree to:

1. Open and demonstrate the strength of the colony as selected by the grower.
2. Deliver the bees to the crop and remove them as specified in the agreement in such a way as to provide the best pollination of the crop. There should be penalties for late delivery, inferior standard, early removal of colonies, or inadequate servicing of them by the beekeeper.
3. Insure that the colonies will remain in good condition while pollinating the crop.
4. Assume public liability for stinging and adhere to local ordinances. There should be clauses specifying rewards for delivery of colonies or service in excess of the minimum, and early or prompt payment of pollination fees.

THE EXTENSION SERVICE CAN HELP

The Extension Service can help with the problems that beset crop producers and beekeepers. Problems can be identified, their sources and extent delineated, and solutions suggested. Interdisciplinary groups composed of growers, beekeepers, agronomists, horticulturists, entomologists, and pesticide applicators could be brought together to reach solutions to mutual problems.

The first meeting of such a group should be publicized. Use mass media (television, radio, and newspaper) to announce the meetings. Letters should be written to special interest groups in the community.

Select subject matter for a workshop carefully. Special consideration should be given to such subjects as: the importance of pollination to the agricultural industry, hazards of the misuse of pesticides, pesticide use law, written agreements between grower and beekeeper, bee protection and crop protection, communication, and cooperation between the various parties. Timely educational materials and newsletters should be developed and distributed.

SAMPLE PROGRAM FOR STATE EXTENSION SPECIALISTS

State Extension specialists should first determine the problems of using honey bees and other pollinating insects to pollinate plants, find solutions, and develop an educational program for implementing the solutions. This should be done in close cooperation with all disciplines involved. The following steps may be used as a guide.

A. Address a questionnaire to beekeepers and producers to find out:
   1. What are the most important problems of using insects for pollination of crops in the State, with emphasis on audiences, crop importance, need for pollination, problem areas, and role of insects.
   2. What has been done to help solve these problems.
   3. What additional research needs to be done to help solve these problems, and how can this research be obtained.
   4. What activities or programs should be planned to assist in using insects to pollinate crops.
   5. Other comments regarding use of insects to pollinate plants.

B. Obtain other needed information by:
   1. Reviewing literature.
   2. Interviewing scientists, State and Government specialists, commercial growers, beekeepers, pesticide applicators, and others.
   3. Assisting in initiating, conducting, and analyzing research.

C. Implement an educational program, using methods such as:
   1. Promoting better communication among beekeepers, farmers, and pesticide applicators.
   2. Arranging and conducting meetings to discuss problems and plans.
   3. Developing timely publications and newsletters for dissemination to individuals and State newspapers, radio and television stations, and others in public and private associations.
   4. Developing timely news releases and visual aids for farm broadcasters and editors.
   5. Establishing improved liaison between State beekeeper organizations and commodity organizations to enhance the use of insects in pollinating crops.
   6. Conducting demonstrations for beekeepers, crop producers, and pesticide applicators to show how to work out problem areas unique to their operations. (A sample workshop schedule follows.)

SAMPLE WORKSHOP SCHEDULE
(Duration 2 Days)

FIRST DAY

8:00 - 9:00 A.M.	Registration of all participants (use name tags for identification)
9:00 - 10:00 A.M.	INTRODUCTIONS a. Persons responsible for workshop—Extension Agents: Agronomist, Apiculturist, Entomologist, and Pesticide Applicators b. Other Government employees and officials—ARS, ASCS, SCS, EPA, Vo-Ag, county officials, workshop participants — beekeepers and growers.
10:00 - 10:30 A.M.	BREAK
10:30 - 12:00	Purpose of workshop, nature of problem
12:00 - 1:00 P.M.	LUNCH
1:00 - 2:25 P.M.	The importance of pollination to the agricultural industry. How insect pollination is accomplished, and local crops that benefit. a. Field crops: legume, oilseed b. Vegetable crops: cucurbits, cole crops, umbelliferous crops c. Fruit and nuts: almonds, apples, blackberries, plums, prunes, etc.
2:45 - 3:00 P.M.	BREAK
3:00 - 4:30 P.M.	The relative importance of crop production to the beekeeper as a pollinator and as a honey producer. a. Cultivated crops as honey sources. b. Good bee pasture or bee locations. c. Choosing between pollination and honey production.

d. The importance of permanent locations for the beekeeper.

e. Factors affecting the prosperity of the beekeeper.

4:30	ADJOURNMENT

SECOND DAY

8:00 - 10:00 A.M.	The written agreement a. The producer's obligations. b. The beekeeper's obligations. c. The necessity to have written agreements.
10:00 - 10:15 A.M.	BREAK
10:15 - 12:00	Items of the contract a. Factors affecting pollination fees. b. Why some fees will be higher. c. Regulations regarding pesticide use while bees are pollinating the crop.
12:00 - 1:00 P.M.	LUNCH
1:00 - 2:45 P.M.	The use of pesticides a. The need for pesticides. b. How pesticides can be used with the least damage to beneficial insects, especially the honey bee (toxic vs. non-toxic pesticides). c. Methods of applying pesticides. d. Timing of applications. e. Pesticide drift.
2:45 - 3:00 P.M.	BREAK
3:00 - 4:30 P.M.	The pesticide use law a. Obligations of the growers. b. Obligations of the beekeepers. c. Obligations of the pesticide applicators. d. The need for mutual respect and understanding among concerned parties.
4:30 P.M.	ADJOURNMENT

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APPENDIX—RESEARCH IN PROGRESS

Most of the research work on bees, pollinating insects, pollination, and apiculture is conducted by public agencies, while some is done by beekeeping equipment manufacturers and by beekeepers. The beekeeping industry (both public agency and private interests) is handicapped by a shortage of qualified personnel. It is important that the industry find replacements or additional personnel for needed research and technical positions for the future. An accelerated training and recruitment program should be initiated to find and interest individuals in the areas of insect pollination and its importance to the agricultural industry.

Public agencies along with the industry should assemble a list of problems, develop training programs, and encourage graduate students to work on problems of the industry as thesis assignments. This training should be both practical and technical.

Accelerated research and training for conducting educational programs are needed to help solve immediate as well as long-range problems. Research should be conducted at several locations in the United States because problems vary greatly, depending on crops, weather, types of operations, and geographical areas. Beekeepers and equipment manufacturers as well as public agencies should continue research.

The Agricultural Research Service, U.S. Department of Agriculture, conducts research in six field laboratories:

1. Bee Breeding and Bee Stock Center, Baton Rouge, La., cooperating with the Louisiana Agricultural Experiment Station. Bee breeding and genetics, nosema disease, maintenance and dissemination of honey bee stocks, and development of improved stock maintenance technology.
2. Bioenvironmental Bee Laboratory, Beltsville, Md. Bee diseases and their control; relationship of bee nutrition to bee population levels; disease diagnostic service for beekeeping industry; effect of environmental factors on bee population levels; pesticides and their effect on bees; and air, water, and plant pollution effects on honey bees.
3. Bee Disease Control Laboratory, Laramie, Wyo., cooperating with Wyoming Agricultural Experiment Station. Bee diseases in open colonies, mode of transmission of bee diseases within and between colonies, disease resistance, and bee poisoning.
4. Bee Management Laboratory, Madison, Wis., cooperating with Wisconsin Agricultural Experiment Station. Management of colonies for honey production and pollination. Use of two queen colonies, bee disease control, queen rearing, and feeding of pollen supplements.
5. Bee Research Laboratory, Tucson, Ariz., cooperating with Arizona Agricultural Experiment Station. Pollination of various crops, bee nutrition and physiology, bee behavior, and effect of pesticides on bees.
6. Bee Biology and Systematics Laboratory, Logan, Utah, cooperating with Utah Agricultural Experiment Station. Commercial use of wild bees as pollinators, effect of pesticides on wild bees, and biological studies of potential wild bee pollinators.

The U.S. Department of Agriculture also occasionally awards specific apiculture research grants in cooperation with State Agricultural Experiment Stations and with foreign countries where such research is of interest to the United States beekeeping industry. Research in apiculture is also conducted by several State Agricultural Experiment Stations.

The U.S. Department of Agriculture has a storage-retrieval system of information on project abstracts called "Current Research Information Systems" (CRIS). This includes information on research in the area of bees, pollinating insects, pollination, and apiculture. Information about this system can be obtained from any State Agricultural Experiment Station.

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